IX. DESCRIPTION OF THE TYPE OF UINTASAURUS DOUGLASSI HOLLAND

By W. J. Holland

(Plates X—XIV)

Among the fossil remains obtained in the quarry in Uinta County, Utah, which was discovered and opened by Mr. Earl Douglass while making researches on behalf of the Carnegie Muesum in the year 1908-1909, and then subsequently in the year 1915 set apart by presidential proclamation as "The National Dinosaur Monument," there is considerable material representing a large sauropod dinosaur, which appears to belong to an undescribed genus. In my *Annual Report* as Director of the Carnegie Museum for the year 1919, p. 38, I stated that I had given to this animal the name *Uintasaurus douglassi* in honor of its discoverer.

While there is in our possession a large amount of material which in my opinion is probably referable to this same genus and species, much of it has not been extricated from the matrix, and that portion, which has been worked out, is at the present time so situated that its careful study and description is difficult. Under these circumstances it seems best to publish the description of the specimen, which was originally designated by me in the *Catalog of Vertebrate Fossils of the Carnegie Museum* as the type of the genus and species, without waiting until a more complete monographic paper upon the subject can be written. The specimen was contained in the original package numbered by Mr. Douglass as Box CCLXIII (263) designated in the list sent in by him from the field as "Block No. 150 M." The field notes made by Mr. Douglass suggested that the block contained "two vertebræ." As the specimen had been only partially uncovered and was found not very far from certain cervicals of very great length, it was supposed by Mr. Douglass that this block contained two similar vertebræ. When, however, the task of extricating the bones was completed, it was found that the block contained five comparatively short vertebræ, but with enormously long cervical ribs. The specimen was carefully freed from the matrix by Mr. Louis S. Coggeshall and mounted by him. It bears the Carnegie Museum Acc. No. 5873 and the Div. No. 11069, (*Carnegie Museum Catalog of Vertebrate Fossils*).

CERVICAL VERTEBRÆ[1]

The cervical vertebræ vary in number in the genera of the Sauropoda, as recent studies show. They have been definitely found to be fifteen in the genus *Diplodocus* and in the genus *Apatosaurus*, perfect series of the cervicals of which, articulated at the time of discovery, are preserved in the Carnegie Museum. On the assumption that in the case of the genus, with which we are dealing in the present paper, the vertebral formula did not differ from that of the above genera, the cervicals in the type specimen of *Uintasaurus douglassi* would be, without doubt, the eleventh, twelfth, thirteenth, fourteenth, and fifteenth. One of my assistants in the paleontological laboratory suggested to me at one time that the posterior vertebra of the series under discussion might possibly be regarded as the first dorsal. I was at first inclined to coincide with this view, but a more careful study of the specimen has led me to conclude that the determination just given is most likely to be correct. Nevertheless, although convinced of the correctness of the relative position assigned to these bones in the series, I have, in the light of quite recent discoveries refrained from giving them numerical position in the cervical series. The recent uncovering of a closely allied form at the Carnegie Museum having only twelve cervicals makes it prudent to suspend judgment.

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[1] Osborn and Mook in their paper upon *Camarasaurus, etc.* (*Memoirs* A. M. N. H., New Series, Vol. III, Part III, pp. 290, *et seq.*), in discussing the cervical vertebræ of *Camarasaurus*, contained in the Cope Collection, now a part of the collections of the American Museum of Natural History, estimate the number of cervicals in *Camarasaurus* as having been thirteen. The material at their command is admitted by them to be manifestly defective, and their conclusion to be only an approximation. Their statement on p. 291 that "Apatosaurus is known to have thirteen cervicals, including the atlas and axis" is one which must be corrected. *Apatosaurus*, like *Diplodocus*, is positively known by the writer and his fellow-students to have had fifteen cervical vertebræ, including the atlas and axis. In the mounted specimen of *A. louisæ* Holland in the Carnegie Museum, the cervical vertebræ were found regularly articulated in order from the first to the last and they number fifteen. The restoration of *Camarasaurus* effected by Osborn and Mook is believed by the writer to be doubtfully correct. Whether the number of the cervicals in *Camarasaurus* was the same as in the genera *Diplodocus* and *Apatosaurus*, in which it is definitely known that the cervicals were fifteen in number is a question yet to be decided.

The five vertebræ which form the type of *Uintasaurus douglassi* are articulated. The last two are bent to the right, thus on the left side more or less exposing their anterior extremities to view, and enabling quite accurate measurements to be made of the length and height of their anterior articulating extremities, as well as of the entire length of the centra (See Pl. XIII). The ends of the second and third vertebræ of the series are so closely articulated that similar measurements in their case are only approximations, but, as given, reasonably exact. The first three vertebræ are very nearly perfect on their right sides, and also on their left sides, save that in the foremost of the series on the left side the tubercular process of the rib and the tip of the transverse process have been lost, making the lateral arch therefore incomplete, and the ends of the shafts of the two anterior ribs have been broken off. The last two vertebræ are more or less imperfect on both sides, the lateral arches being incomplete in the foremost of the two and wholly wanting in the last. Nevertheless, enough remains in both cases to enable us to closely approximate their outlines and characteristic features in life. (See Plates X–XIII).

The most remarkable feature of the cervicals we are considering is the very great backward prolongation of the cervical ribs, which reaches its greatest extent in the foremost of the series which we are engaged in studying. This feature will be made clearer in the more detailed description and the figures which follow. In addition there are other structural features which widely separate these vertebræ from the corresponding bones in other genera of the Sauropoda which have been described. The centra are strongly opisthocœlous, comparatively short, with broad flattened inferior surfaces, and have a markedly transverse oval contour in cross-section. The latter feature may have been in this particular specimen somewhat accentuated by vertical crushing, but, making all allowance for the crushing which is apparent, an oval outline with the longer axis of the oval horizontally transverse to the main axis of the vertebral series must be accepted as one of the characteristics of these vertebræ.

The pleural cavities of the centra ("pleurocels" of Osborn and Mook) are relatively long, and vertically narrow in the two front vertebræ, but rapidly diminish in size as we proceed from the first to the last vertebra of the series. The prezygapophyses extend well beyond and overhang the anterior extremities of the centra; the postzygapophyses extend very slightly, or not at all, backward beyond a vertical rising from the posterior margin of the cups of the centra. The arch formed by the cervical ribs through their lateral articulations is very large and rounded, not high and narrow; it is formed below by the capitular process of the rib, which in the first three vertebræ before us is expanded into a wide, flattened plate with a deep saucer-shaped, or pocket-shaped depression on its upper surface before the point where it articulates with the lower margin of the centrum, and by the tubercular process, which is modified so as to form a lengthy ascending, and outwardly curved bone, articulating at its upper extremity with the transverse process. The capitular process in relation to the centrum extends outwardly and strongly downwardly and the lateral arch in its lower portion lies below the level of the ventral surface of the centrum. The transverse process may be described as being formed by the union of an outwardly flaring lamina of bone (the "infrapostdiapophysial lamina" of Osborn and Mook) springing from the upper margin of the centrum, just before the cup, running forward and outward and met a little behind the neck of the ball by a similar but much shorter lamina (the "infraprediapophysial lamina" of Osborn and Mook) running slightly backwardly and abruptly outwardly. At their line of contact, the laminæ fuse and project downward forming a thin, perpendicular, beam-like support, the transverse process, which bears on its upper

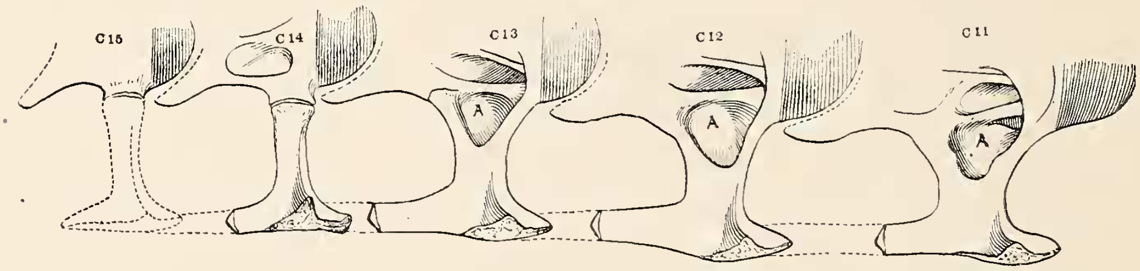

Fig. 1. View from above, showing outline of the capitular processes of the cervical ribs and the pocket-shaped depressions at A. The tubercular processes are removed to permit a full view. (*Greatly reduced in size*).

surface the zygapophysial plate (the "horizontal lamina" of Osborn and Mook). At its outer extremity the transverse process anchyloses with the tubercular process of the rib. The zygapophysial plates, one on either side, viewed laterally are somewhat saddle-shaped; viewed from above they present in rough outline the form of an oblique parallelogram. Of this parallelogram the anterior corner, which is nearest the axis of the vertebra, bears the articulating prezygapophysial surface, looking upward; the anterior outer angle enters into the composition of the upper part of the transverse process; the outer posterior angle bears the articulating postzygapophysial surface, looking downward; and the posterior inner angle enters into the composition of the upwardly extended surface of the dorsal process, which rises at this point, being connected with the postzygapophysial surface by an elevated ridge which runs along the inner margin of the zygapophysial plate, gradually thickening inwardly and melting into the dorsal process. The dorsal processes are arranged in pairs, or, upon the hypothesis that there is normally but one spine, this spine may be said to be broadly bifid at its extremity. Inwardly at their bases the dorsal processes fuse with and enter into the composition of the flattened plates of bone, which, supported on either side by the pedicles, constitute the floor of the great longitudinal nuchal valley and the roof of the neural canal. Both the prezygapophyses and the postzygapophyses find support and reinforcement from below by strong columnar pedicles, that of the prezygapophysis extending forward and outward and being thicker and more massive at its distal extremity than at its point of origin on the centrum near the neck of the ball; the pedicle supporting the postzygapophysis being relatively short vertically, but wide anteroposteriorly, extending forward along the side of the neural canal, into the composition of the outer wall of which it seems to enter. At the point, where the anterior pedicle arises from the upper surface of the centrum near the neck of the ball, there also arise inwardly on each side thin laminæ of bone, which, extending inwardly and upwardly and meeting on the median line, form the lateral and superior walls of the neural canal in the anterior portion of the vertebra. Between these laminæ and those forming the floor of the overlying median nuchal channel, there is, as seen from in front, a triangular vacuity, bounded outwardly by the anterior pedicle, which supports the prezygapophysis. How far back this vacuity extends it is impossible at present to say, as it has not been deeply explored for fear of injuring the specimen. The neural canal is suboval in outline, but, as there has undoubtedly been some crushing, its ovality in life undoubtedly was less than is shown by the material under examination.

For comparison I introduce at this point figures of lateral views of the fifth predorsal cervical vertebræ of *Apatosaurus*, *Diplodocus*, *Uintasaurus*, and *Haplacanthasaurus*, as well as of the hypothetical outline of the same bone in *Camarasaurus* as given by Osborn and Mook (*Memoirs* A. M. N. H., Vol. III, Part III, Pl. LXVII). An examination of these outline-drawings will serve to bring more clearly into view the differences which exist between the corresponding vertebræ in these genera than can be done by merely verbal description.

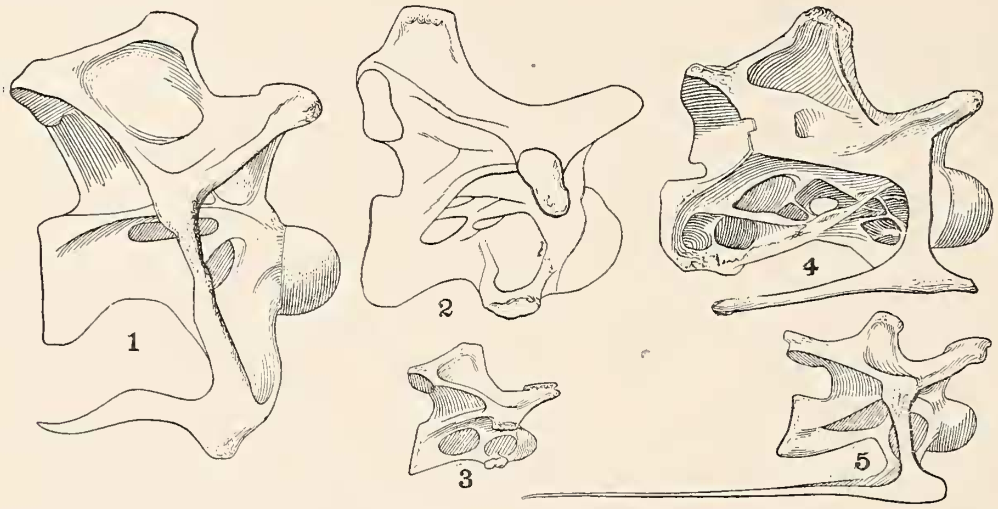

Fig. 2. No. 1, fifth predorsal vertebra of *Apatosaurus louisæ* Holland, outline of right side from an as yet unpublished drawing; No. 2, Do., *Camarasaurus supremus* Cope, adapted from Osborn and Mook, Mem. A. M. N. H., new ser., Vol. III, Part III, Pl. LXVII; No. 3. Do., *Haplacanthasaurus utterbacki* Hatcher, Mem. Carn. Mus., Vol. II, Pl. II; No. 4, Do., *Diplodocus carnegiei* Hatcher, Mem. Carn. Mus., Vol. I, Pl. IV; No. 5, Do., *Uintasaurus douglassi* Holland. (All figures one-fortieth natural size).

After the foregoing general description of the cervicals I proceed to a somewhat more detailed account of each of them, accompanied in each case by a table of measurements.

Fifth Predorsal Vertebra.—The centrum is more or less oval in cross-section. The ball is wide transversely, somewhat flattened dorsally, and more regularly curved ventrally. (See Fig. 3, No. 2.) The cup is deep, with the margin of its lower lip produced further backward than the margin of the upper lip. The pleurocentral cavities are deep, longer than high, extending anteroposteriorly for about six-tenths of the total length of the centrum. These cavities are divided about the middle by a longitudinal lamina, extending backward and upward at an acute angle with the axis of the centrum. Below this median septum there is a shorter septum originating lower down back of the inner wall of the ball and extending backward and downward and vanishing into the lower edge of the centrum, where its outer margin enters into the composition of the inner border of the saucer-shaped depression lying on the upper surface of the capitular process of the rib where it unites with the centrum. The zygapophysial plates on their outer margins before the transverse process are gently curved outwardly as is shown by the moiety preserved on the right side, which has not been injured; between the transverse process and the postzygapophysial articulation the plate is deeply excavated, or inwardly curved, as is shown by

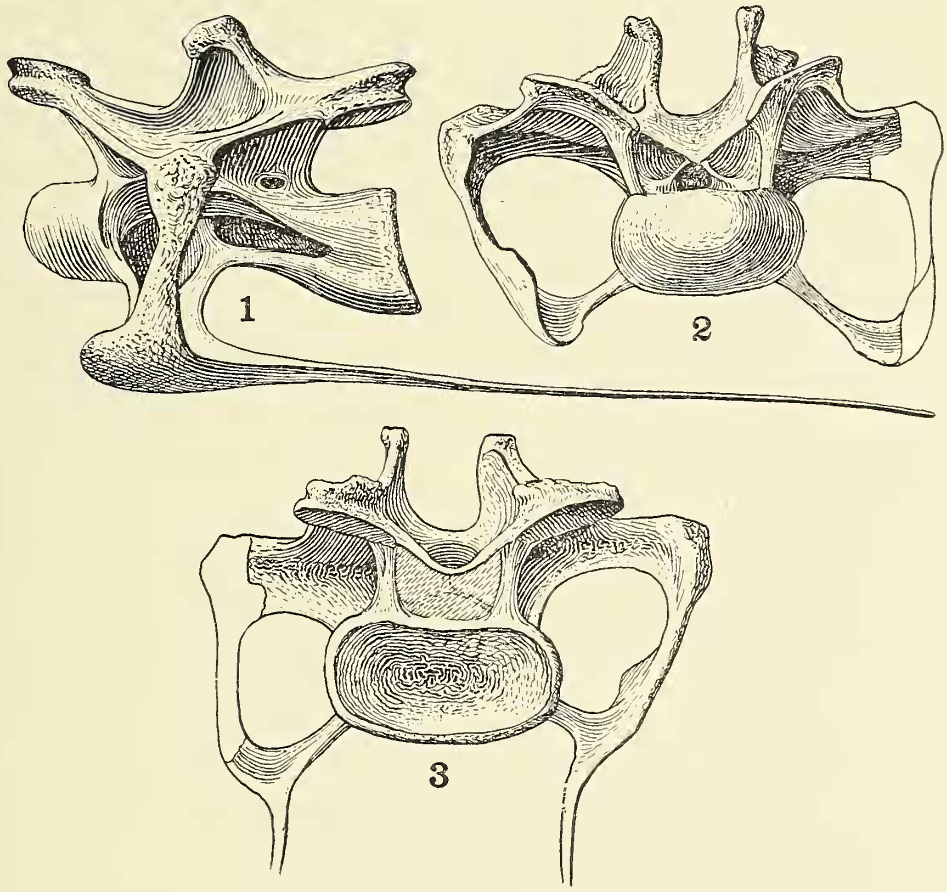

Fig. 3. Fifth predorsal vertebra of *Uintasaurus douglassi* Holland. 1, lateral view; 2, anterior view; 3, posterior view. One-tenth natural size. *Type.* C. M. Cat. Vert. Foss. No. 11069. (Fig. 1 does not exactly represent the pleurocellular laminæ, W. J. H.)

the moiety of the left side, which has not been so much injured as the corresponding part of the bone on the right side. On this latter side the bone at this particular point has been badly crumpled and disfigured by pressure. The spinous processes are somewhat lower than those of the following vertebra and at their extremities have been somewhat restored, and in consequence their height, as given in the following table of measurements, is only an approximation, but nevertheless very nearly correct. The anterior margin of the bases of the dorsal processes are continued forward as an elevated ridge upon the upper surface of the zygapophysial plate toward the prezygapophysis, before quite reaching which this ridge disappears, dying out upon the anterior surface of the plate. This ridge posteriorly unites with the corresponding elevation of the opposite side on the median line forming a raised bar of bone which subtends the space between the two dorsal processes over the roof of the neural canal, thus strengthening the latter. In other respects the body of the vertebra corresponds with the general description, which has already been given.

The most remarkable feature of this vertebra is revealed in the cervical ribs. That of the right side is complete and perfect in every particular; that of the left side has been broken, not much more than the anterior half of its shaft having been preserved. At the anterior extremity the cervical rib is thin and relatively broad, curving slightly upward on the inner and outer edge. There is a short anterior rounded projection beyond the capitular and tubercular processes. This anterior projection on its upper surface is dished or excavated, this excavated surface being separated from the remainder of the shaft by a low, sharply defined ridge, which is an inward extension of the sharpish ridge which runs along the inner side of the tubercular process. The capitular portion of the rib is a broad flat plate which widens as it approaches its line of articulation with the lower margin of the centrum and encloses between its gradually upturned and thickened margins, as it nears the centrum, a quite deep saucer-shaped depression with an outer pocket-like cavity. This saucer-shaped depression passes into and merges with the pleurocentral cavity, being slightly separated from the latter by the bony ridge, which marks the backward prolongation of the lowermost short bony septum, which arises near the base of the neck of the ball. The tubercular process of the rib, which is immediately opposite to the capitular process, is modified so as to form a long outwardly curving rod of bone, flattish or slightly rounded on its outer surface, inwardly quite sharply ridged (triangular in cross-section). It extends upward, outward, and then inward, and finally coössifies with the outer extremity of the transverse process. The shaft is very long, running backward from the region of its articulating processes to beyond the middle of the centrum of the third, or antepenultimate, vertebra of the series; curved, or slightly trough-like on its upper side near its anterior extremity behind the origin of the articulating processes, and bending downward near its posterior extremity.

Measurements

Distance from neck of ball to margin of cup at the middle of the centrum	280 mm.
Length of centrum over all	365 mm.
Length of ball of centrum	85 mm.
Greatest transverse diameter of ball at neck	185 mm.
Greatest vertical diameter of ball at middle	105 mm.
Height of vertebra from base of centrum to top of dorsal processes	250 mm.
Width between extremities of transverse processes	445 mm.
Width between outer margins of prezygapophyses	285 mm.
Width between outer margins of postzygapophyses	295 mm.
Anteroposterior diameter of pluerocentral cavity	190 mm.
Greatest vertical height of pleurocentral cavity	95 mm.
Greatest depth of pleurocentral cavity (approximate)	45 mm.
Height of dorsal processes above median symphysis	90 mm.
Anteroposterior diameter of dorsal processes at their tips	50 mm.
Anteroposterior diameter of dorsal processes at base (approximate)	110 mm.
Length of articulating surfaces of prezygapophyses	50 mm.
Width of articulating surfaces of prezygapophyses	100 mm.
Length of articulating surfaces of postzygapophyses	50 mm.
Width of articulating surfaces of postzygapophyses	70 mm.
Length of shaft of cervical rib over all	770 mm.
Width of shaft of cervical rib just behind origin of processes	50 mm.
Width of shaft of cervical rib at posterior extremity	8 mm.
Length of capitular process from middle of shaft to centrum	105 mm.
Width of capitular process at its middle (narrowest point)	75 mm.
Length of tubercular process of rib from middle of shaft to union with transverse process (measured on the inner curve)	130 mm.
Width of tubercular process about middle (narrowest point)	30 mm.
Diameter of neural canal (approximate, crushed down)	35 mm.

Fourth Predorsal Vertebra.—The general contour and arrangement of the various elements in this member of the vertebral series is quite analogous to that in the preceding vertebra, making allowance for such modifications as result from diminution in length and increase in height and width. The cervical ribs are preserved on both sides, that on the right side being apparently quite perfect, that on the left side being considerably shorter than its fellow of the opposite side. Whether the diminution in the length of the left rib is due to natural causes and is occasioned by asymmetrical growth, or whether it is due to the fact that some interstitial fragments were lost at the time the specimen was taken up in the quarry, is not clear.

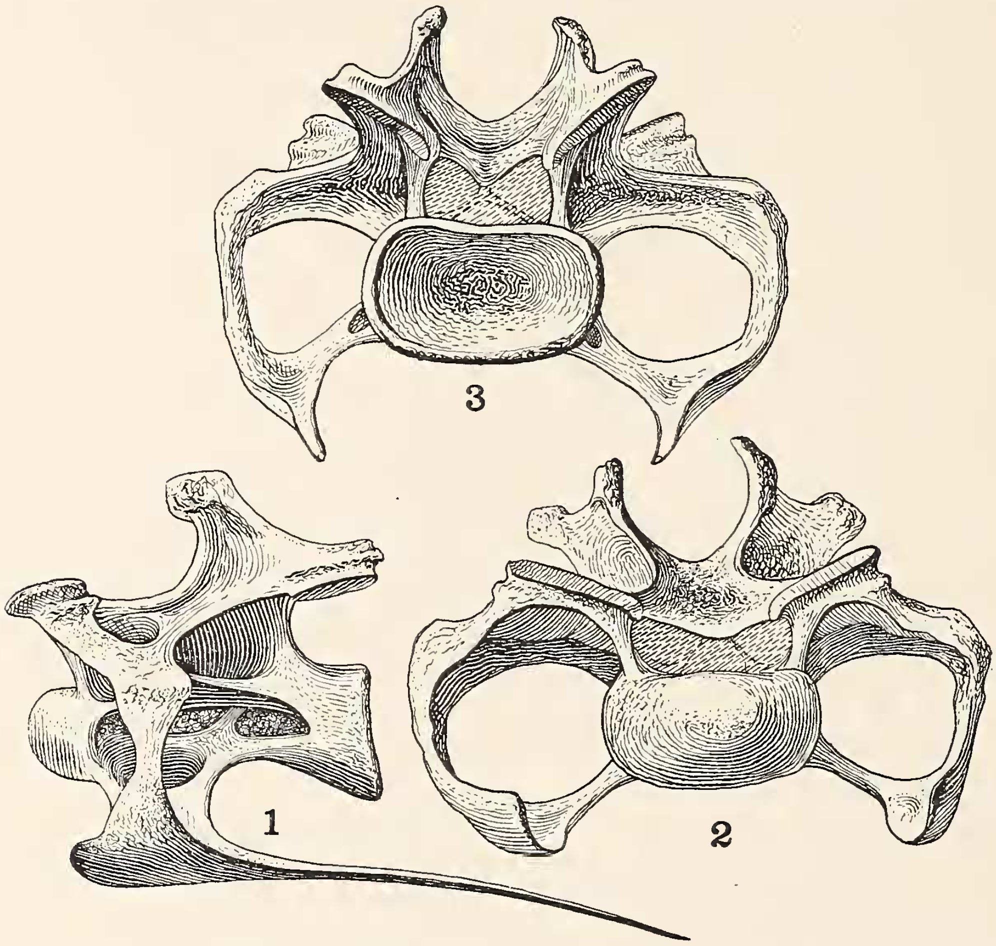

Fig. 4. Fourth predorsal vertebra of *Uintasaurus douglassi* Holland, 1, lateral view; 2, anterior view; 3, posterior view. One-tenth natural size. C. M. Cat. No. 11069.

The shaft of the rib is very slender, and on the left side had been more or less comminuted before being received at the laboratory. The preparator has very skillfully cemented the fragments together, but there is a suggestion that he may not have had all the fragments at hand when he made the restoration, and that in consequence this long and very slender bone may be a little shorter in the specimen than it was in life. The zygapophysial plate has its anterior margin from the prezygapophysis to the transverse process somewhat more strongly rounded than is the case in the preceding vertebra, and the margin between the transverse process and the postzygapophysis more deeply excavated. The ridges running forward and backward from the base of each spinous process are higher and the dorsal process also projects outwardly more than in the preceding vertebra, resulting in the formation of a deep, triangular, inwardly pointed, lateral, pocket-shaped cavity at the base of the spinous process. This structure appears in the succeeding vertebræ, gradually increasing in depth, as we trace it backward. It is brought into view on Plate XII.

Measurements[2]

Distance from the neck of the ball to the margin of the cup at middle of the centrum	250 mm.
Length of centrum over all (approximate)	300 mm.
Length of ball of centrum (approximate)	50 mm.
Greatest transverse diameter of ball (approximate)	195 mm.
Greatest vertical diameter of ball (approximate)	110 mm.
Height of vertebra from base of centrum to top of dorsal processes	270 mm.
Width between extremities of transverse processes	465 mm.
Width between outer margins of prezygapophyses	315 mm.
Width between outer margins of postzygapophyses	320 mm.
Anteroposterior diameter of pleurocentral cavity (right side)	180 mm.
Greatest vertical diameter of ditto (right side, best preserved)	90 mm.
Depth of pleurocentral cavity (approximate)	40 mm.
Height of dorsal processes in front above median symphysis	140 mm.
Anteroposterior diameter of dorsal processes at tips	70 mm.
Anteroposterior diameter of dorsal processes at base	130 mm.
Length of articulating surfaces of prezygapophyses	50 mm.
Width of articulating surfaces of prezygapophyses	70 mm.
Length of articulating surfaces of postzygapophyses	60 mm.
Width of articulating surfaces of postzygapophyses	120 mm.
Length of shaft of cervical rib over all (right side, best preserved)	560 mm.
Width of shaft of cervical rib just behind origin of processes	60 mm.
Width of shaft of cervical rib at posterior extremity	8 mm.
Length of capitular process from middle of shaft to centrum	140 mm.
Width of capitular process at middle, where narrowest	75 mm.
Length of tubercular process from middle of shaft to union with transverse process, measured on the inner curve	140 mm.
Width of tubercular process, anteroposteriorly, about middle, (narrowest part)	30 mm.
Diameter of neural canal (invisible)	......

Third Predorsal Vertebra.—This vertebra differs from the one immediately anterior to it by being greatly reduced in length, accompanied by a corresponding increase in width and height. The lateral arch is much enlarged, while the shaft of the cervical rib is greatly reduced in length. The zygapophysial plate becomes narrower antero-posteriorly and longer laterally, while retaining its saddle-shaped contour when viewed from the side. The spinous processes increase in height and are connected from their bases with the pre- and postzygapophyses by ridges like those on the two preceding vertebræ, which however, are much higher and fuse above with the margins of the articulating surfaces of the pre- and postzygapophyses, the posterior ridge being the higher and above bending forward somewhat, so as to overhang the deep lateral pit at the base of the dorsal process. This ridge lies at a less acute angle with the axial line of the vertebræ than the corresponding ridge on the preceding vertebræ. The tubercular and capitular processes of the cervical rib in this vertebra are

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[2] This and the following vertebra being articulated, it has not been possible to give the exact length of the ball or the depth of the cup into which it enters.

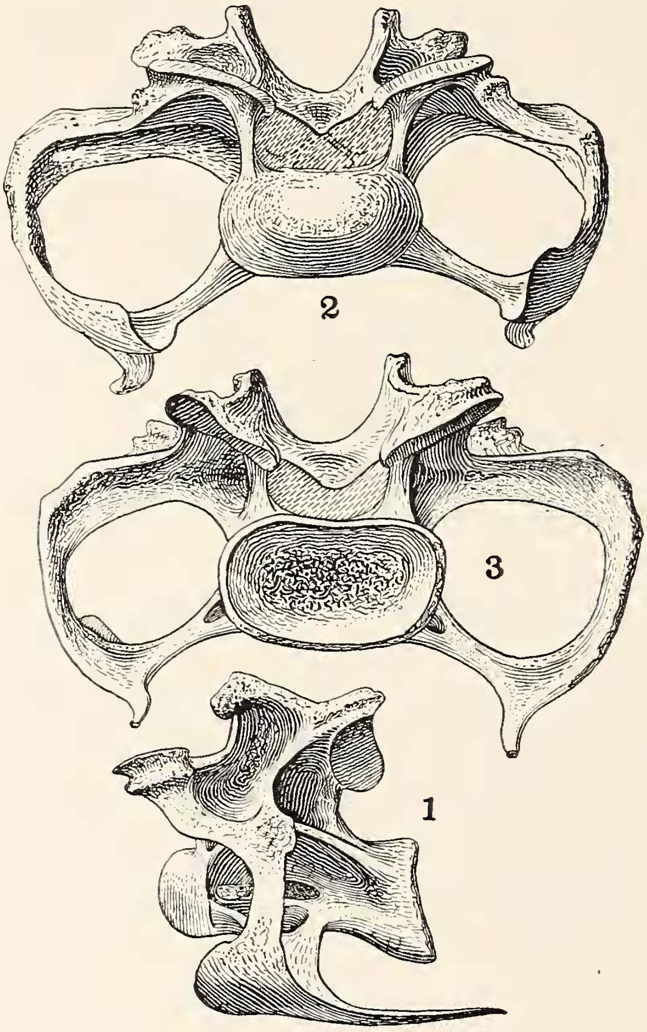

Fig. 5. Third predorsal vertebra of *Uintasaurus douglassi* Holland. 1, lateral view; 2, anterior view; 3, posterior view. One-tenth natural size. C. M. Cat. No. 11069.

longer than in the preceding vertebræ. The deep saucer-shaped cavity on the upper side of the inner end of the capitular process is not so wide as in the preceding vertebræ, but deeper. It may be mentioned here that this peculiar structure disappears in the next two succeeding vertebræ, and that this is the last of the series of cervicals in which it comes into view. In Figure 1 there is represented in outline the arrangement of the depressions found on the upper surface of the capitular processes of the cervical ribs viewed from above. It is noticeable that there is no evidence of a distinct parapophysis on the centrum of the three anterior vertebræ of the series of cervicals before us. In the two posterior vertebræ the parapophyses are distinctly revealed. Complete coössification has taken place between the heads of the widely expanded capitular processes and the lower margin of the centrum in the three anterior vertebræ.

MEASUREMENTS

Distance from neck of ball to margin of cup	220 mm.
Length of centrum over all (approximate)	260 mm.
Length of ball of centrum (approximate)	40 mm.
Greatest transverse diameter of ball	225 mm.
Greatest vertical diameter of ball	120 mm.
Extreme depth of cup (approximate)	30 mm.
Height of vertebra from base of centrum to top of dorsal processes	280 mm.
Width between extremities of transverse processes	600 mm.
Width between outer margins of prezygapophyses	335 mm.
Width between outer margins of postzygapophyses	345 mm.
Length of pleurocentral cavity	160 mm.
Greatest vertical height of pleurocentral cavity	85 mm.
Greatest depth of pleurocentral cavity (approximate)	25 mm.
Height of dorsal processes above median depression between them	170 mm.
Anteroposterior diameter of dorsal processes at their tips	60 mm.
Anteroposterior diameter of dorsal processes at base (approximate)	145 mm.
Length of articulating surfaces of prezygapophyses	60 mm.
Width of articulating surfaces of prezygapophyses	120 mm.
Length of articulating surfaces of postzygapophyses	75 mm.
Width of articulating surfaces of postzygapophyses	145 mm.
Length of shaft of cervical rib, over all	335 mm.
Width of shaft of cervical rib just behind origin of processes	80 mm.
Width of shaft of cervical rib at posterior extremity	15 mm.
Length of capitular process from middle of shaft to centrum	195 mm.
Width of capitular process at its middle	70 mm.
Length of tubercular process from middle of shaft to union with the transverse process (measured on the inner curve)	185 mm.
Width of tubercular process about its middle (anteroposteriorly)	35 mm.
Diameter of neural canal (invisible)	.. ..

Second Predorsal Vertebra.—The progressive shortening in length and gradual increase in width and height, which is characteristic of the preceding vertebræ, as we trace them backward in the series, also reveal themselves in this vertebra. Unfortunately the vertebra is not as well preserved as those which precede it. The transverse process of the left side has been broken off at its extremity, but fortunately that of the right side remains, so that it is possible by means of it to ascertain the distance between the two extremities. All which remains of the cervical ribs is a considerable portion of that of the right side, consisting of the anterior protruding extremity of the shaft, the capitular process, which is well preserved, and a short part of the shaft following the origin of the processes. The tubercular process, which must have been quite long, is missing. The capitular process is relatively thicker and not as wide as that of the rib of the preceding vertebra. It is trihedral in cross-section, approximately flat on its lower surface; on its upper surface revealing no trace whatever of the saucer-shaped cavity or depression which is so characteristic a feature in the ribs of the preceding vertebræ, and having nearer its anterior than its posterior border above an elevated ridge which is a continuation on the upper surface on the capitulum of the sharp inner ridge which extends along the inner surface of the tubercular process in the rib of the preceding vertebra, where, however, this inner ridge is not so highly developed as it is in this rib. The end of the shaft, where it is broken off behind, shows the cross-section to be triangular. It is plainly evident at this point that a considerable portion of the posterior end of the shaft is missing. The facets for the reception of the capitular process (the parapophyses) on both sides of the centrum are preserved in good condition and appear as very short processes, situated just behind the neck of the ball, below the pleurocentral cavity. The pleurocentral cavity is greatly reduced in size in this vertebra. The zygapophysial plate is considerably narrower than in the preceding vertebra, its posterior outer margin between the transverse process and the postzygapophysis deeply excavated, and the ridges connecting the dorsal processes and the pre- and postzygapophyses higher relatively than in the preceding vertebra and standing in relation to the axial line of the vertebra at a greater angle. The cavity on the upper surface at the base of the dorsal processes, formed by these and the adjacent overhanging ridges, is deep and cone-shaped, pointing inwardly and downwardly toward the median line or axis of the vertebra.

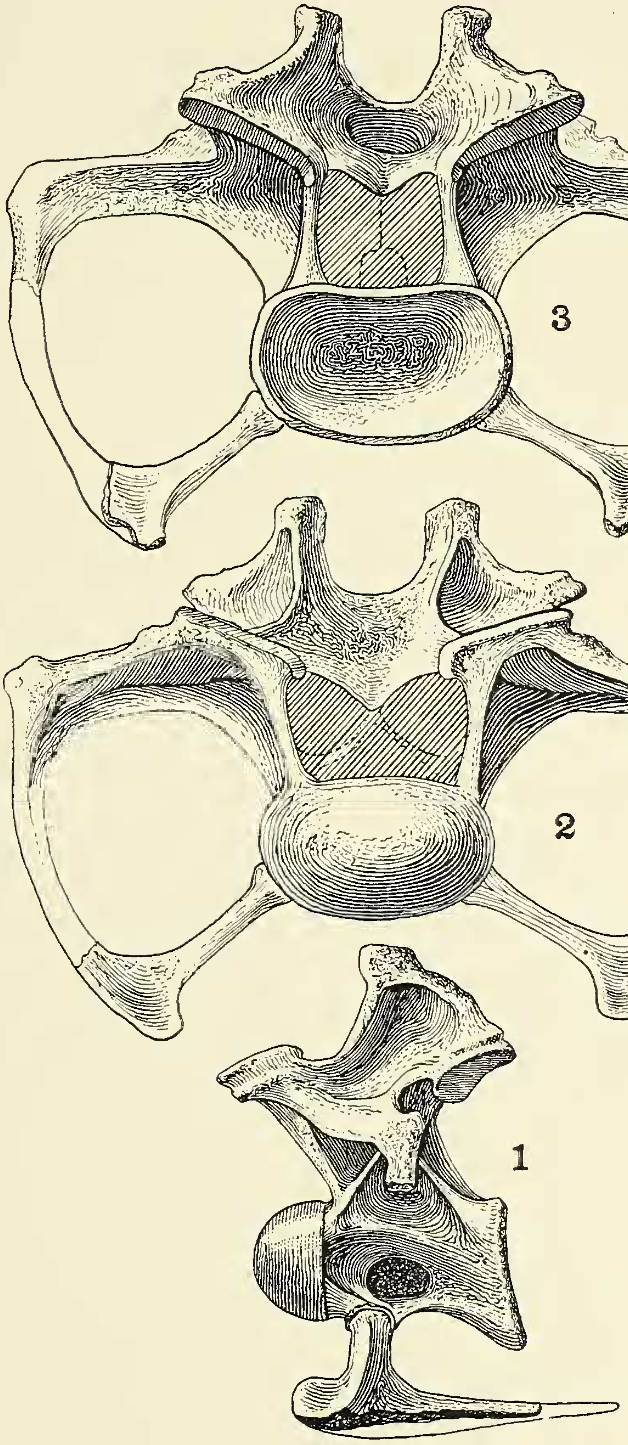

Fig. 6. Second predorsal vertebra of *Uintasaurus douglassi* Holland. 1, lateral view; 2, anterior view; 3, posterior view. One-tenth natural size. C. M. Cat. No. 11069.

Measurements

Distance from neck of ball to margin of cup at middle	185 mm.
Length of centrum over all (approximate)	265 mm.
Length of ball of centrum (exposed to view on left side)	80 mm.
Greatest transverse diameter of ball	210 mm.
Greatest vertical diameter of ball	130 mm.
Height of vertebra from base of centrum to tips of dorsal processes	335 mm.
Width between extremities of tranverse processes [3]	670 mm.
Width between outer margins of prezygapophyses	335 mm.
Width between outer margins of postzygapophyses	400 mm.
Length of pleurocentral cavity	112 mm.
Greatest vertical diameter of pleurccentral cavity, left side	37 mm.
Greatest vertical diameter of pleurocentral cavity, right side	77 mm.
Greatest depth of pleurocentral cavity (approximate)	35 mm.
Height of dorsal processes from median depression between them	175 mm.
Anteroposterior diameters of dorsal processes at tips	55 mm.
Anteroposterior diameter of dorsal processes at base (approximate)	125 mm.
Length of articulating surfaces of prezygapophyses	75 mm.
Width of articulating surfaces of postzygapophyses	120 mm.
Length of articulating surfaces of postzygapophyses	104 mm.
Width of articulating surfaces of postzygapophyses	140 mm.
Length of shaft of cervical rib (approximate) [4]	250 mm.
Width of shaft of cervical rib just behind origin of processes	50 mm.
Width of shaft of cervical rib at posterior extremity	.. ..
Length of shaft of capitular process from middle of shaft to centrum	160 mm.
Width of capitular process at its middle	50 mm.

First Predorsal Vertebra.—As has already been stated, the question has been raised whether the vertebra we are now studying should not be regarded as the first dorsal. Without having made a close study of the material, I was at first inclined to regard this suggestion as being plausible, but upon a closer and more minute investigation, coupled with a careful comparison with the cervicals and anterior dorsals of other genera, of which we possess complete and well articulated vertebral columns, I have found myself forced to abandon the view suggested to me and momentarily accepted by me in conversation. I am satisfied that to accept the vertebra, which we are now studying, as being the first dorsal would be to admit too violent a change in the structure of the vertebral column at this point, involving insuperable mechanical difficulties which are contrary to nature. The first dorsal vertebra is accepted as being the foremost of those which bear dorsal ribs. Upon the supposition that the vertebra before us is the first dorsal, and in life bore a dorsal rib, it follows from what we know of the articulation, the length of the centrum and the cervical rib of the preceding vertebra, which has been hereinbefore described, that the extremity of the shaft of this rib, short as it is, would in life have fallen under the capitular process of the first dorsal rib, thus locking the cervical series of ribs into the dorsal series. Such a condition does not exist in the genera *Diplodocus* and *Apatosaurus*, as is demonstrable, nor does it exist in any other genera of the Dinosauria, so far as I know. In both of the genera mentioned the last cervical rib has its shaft greatly reduced: in *Apatosaurus* it is only a slight posterior projection, a mere knob-like boss; in *Diplodocus* it is extremely short, only projecting backward a few inches. In both genera there is a wide interval between the posterior extremity of the shaft of the last cervical and the capitular process of the first dorsal. This would not be the case if we interpret the vertebra, which is the last of the series before us, as a dorsal, as has been pointed out. Such an arrangement would deprive the vertebral column at this point of all mobility, and though, owing to the singularly great extension backward of the cervical ribs in *Uintasaurus*, the neck of the animal must have been very highly immobile, I am inclined to think that, following the analogies of other genera, it is far more natural to assume that this vertebra is the last of the cervical series rather than the first of the dorsals; that its rib, which in the specimen before us is unfortunately missing, was, as in the other genera of the Sauropoda, provided with a very short shaft, and that between the posterior extremity of this and the first dorsal there was a gap, which admitted of at least some motion of the cervical series of vertebræ where they unite with the succeeding dorsals. Of course there is a possibility of error in this view, but until we obtain a complete series of cervicals interlocking with the succeeding dorsals, I am inclined to prefer it, as most in consonance with what we know of the homologous parts in the other Sauropoda.

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[3] Ascertained by taking twice the distance from the median line to the end of the transverse process of the right side, which is preserved entire.

[4] The length of that portion of the shaft which is in our possession is 184 mm. It is evident that a considerable portion of the posterior end of the shaft is missing, probably as much as 70 mm. in length, if not more. Adding this to the length of the fragment, we ascertain that it must have fallen, like the shafts of the preceding vertebræ, under the capitular process of the succeeding vertebra.

The vertebra is shorter anteroposteriorly than its predecessor, and the ball, exposed to view on the left side, and the cup, in full view behind, are both very broadly oval, the transverse diameter greatly exceeding the vertical diameter. Although the extremities of the transverse processes on both sides are lost, it is evident that no increase in width at this point is taking place, although the width between the outer margins of the pre- and postzygapophyses is greater than in the next antecedent vertebra, and the height from the base of the centrum to the tips of the dorsal processes is also greater. The zygapophysial plate is narrower anteroposteriorly, and deeply incised or excavated between the transverse process and the postzygapophysis on its external border. The pleurocentral cavities on this vertebra

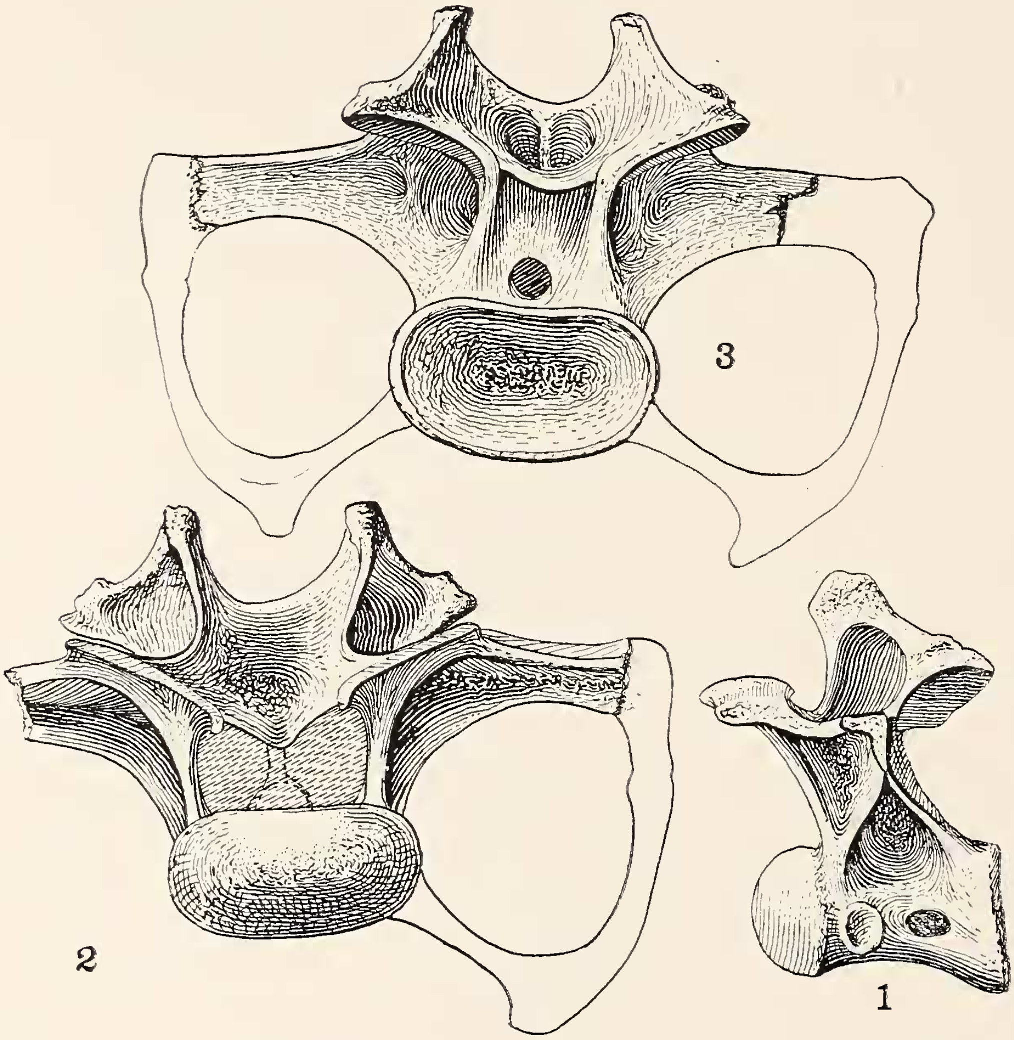

Fig. 7. First predorsal vertebra of *Uintasaurus douglassi* Holland. 1, lateral view of left side; 2, anterior view; 3, posterior view. One-tenth natural size. C. M. Cat. No. 11069.

appear to have become almost obsolete. On the right side the pleurocentral cavity appears as a small oval pocket, filled with matrix. However, the centrum on this side has been so much repaired and filled in with plaster that little can be positively made out as to its lateral structure save its length. On the left side the centrum has sustained very little injury and is not much repaired. On this side the pleurocentral vacuity is merely a small pit just behind the facet for the capitular attachment of the rib. This opening is not analogous in its location to that shown on the opposite side, the latter having a position more to the rear of the centrum. It is proper to call attention at this point to the fact that in both *Diplodocus* and *Apatosaurus* pleurocentral vacuities of considerable size occur on both the last cervical and the first dorsal vertebræ.

MEASUREMENTS

Distance from neck of ball to margin of cup at middle	155 mm.
Length of centrum over all	250 mm.
Length of ball of centrum	95 mm.
Greatest transverse diameter of ball	240 mm.
Greatest vertical diameter of ball	125 mm.
Extreme width of cup	230 mm.
Extreme height of cup	130 mm.
Extreme depth of cup (approximate, filled with matrix)	80 mm.
Height of vertebra from base to top of dorsal processes	340 mm.
Width between extremities of transverse processes (approximate)	600 mm.
Width between outer margins of prezygapophyses	400 mm.
Width between outer margins of postzygapophyses	370 mm.
Length of pleurocentral cavity (right side, approximate)	30 mm.
Vertical height of ditto (right side, approximate)	25 mm.
Greatest depth of pleurocentral cavity (approximate)	15 mm.
Height of dorsal processes above median depression between them	190 mm.
Anteroposterior diameter of dorsal processes at tips	60 mm.
Anteroposterior diameter of dorsal processes at base (approximate)	135 mm.
Length of articulating surfaces of prezygapophyses	104 mm.
Width of articulating surfaces of prezygapophyses	140 mm.
Length of articulating surfaces of postzygapophyses	70 mm.
Width of articulating surfaces of postzygapophyses	120 mm.
Diameter of neural canal (approximate, crushed and occluded by matrix)	35 mm.

The entire length of the series of vertebræ as articulated in the specimen, is 1350 mm., measured from the end of the ball of the first vertebra to the margin of the cup of the last. On the hypothesis that these are the last five vertebræ of the cervical series, we may conclude in a general and approximate fashion that this reptile had a neck about twelve feet in length. It was relatively shorter than in *Diplodocus*, and also in *Apatosaurus*. In comparison with these reptiles it was not only shorter, but wider and flatter. It was also much less mobile, owing to the enormous length of the cervical ribs which, in the case of the anterior vertebræ which we have been studying, overlap not only the whole of the next succeeding vertebra, but the greater part of the one following that.

It is probable that the barrel of the reptile was also somewhat broader in proportion to its height than was the case in the other genera with which comparison has been made in this article. It had little resemblance, so far as can be determined, to *Haplacanthosaurus* and its allies, with which a comparison has been instituted. All the features shown by the vertebræ which have so far been prepared for study, show it to be widely distinct from any other genus of the Sauropoda which has hitherto been described. It is proper at this point to state that, if my surmise as to the association with these cervicals of other remains at our command is hereafter verified, *Uintasaurus*, while having a relatively short neck, had an enormously long tail.

CARNEGIE MUSEUM,
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